Combined Gas Law Problems

1) **A sample of sulfur dioxide occupies a volume of 652 mL at 40.° C and 720 mm Hg. What volume will the sulfur dioxide occupy at STP?**

2) **A sample of argon has a volume of 5.0 dm^3 and the pressure is 0.92 atm. If the final temperature is 30.° C, the final volume is 5.7 L, and the final pressure is 800. mm Hg, what was the initial temperature of the argon?**

3) **322 L of hydrogen occupies a volume of 197 L at STP. If the initial temperature of the hydrogen was 37° C, what was its initial pressure?**

4) **The initial temperature of a 1.00 liter sample of argon is 20.° C. The pressure is decreased from 720 mm Hg to 360 mm Hg and the volume increases to 2.14 liters. What was the change in temperature of the argon?**

5) **A sample of nitrogen gas occupies a volume of 2.00 L at 756 mm Hg and 0.00° C. The volume increases by 2.00 L and the temperature decreases to 137 K. What is the final pressure exerted on the gas?**

6) **A 20. L container is filled with helium and the pressure is 150 atm and the temperature is 30.° C. How many 5.0 L balloons can be filled when the temperature is 22° C and the atmospheric pressure is 755 mm?**

Solutions

1) $P_1 = 720$ mm $\quad P_2 = 760$ mm

$V_1 = 652$ mL $\quad V_2 = ?$

$T_1 = 40.^\circ C + 273 = 313$ K $\quad T_2 = 0^\circ C + 273 = 273$ K

$P_1V_1/T_1 = P_2V_2/T_2$

$V_2 = P_1V_1/T_1 \times T_2/P_2$

$V_2 = 720$ ~~mm~~ x 652 mL x 273 ~~K~~/(313 ~~K~~ x 760 ~~mm~~) = 540 mL SO_2

2) $P_1 = 0.92$ atm $\quad P_2 = 800.$ mm

$V_1 = 5.0\ dm^3$ $\quad V_2 = 5.7$ L

$T_1 = ?$ $\quad T_2 = 30.^\circ C + 273 = 303$ K

$P_1V_1/T_1 = P_2V_2/T_2$

$T_1 = P_1V_1/P_2 \times T_2/V_2$

$T_1 = 0.92$ ~~atm~~ x 760 ~~mm~~/1 ~~atm~~ x 5.0 ~~dm^3~~ x 303 K/(800. ~~mm~~ x 5.7 ~~L~~ x 1 ~~dm^3~~/~~L~~) =

232 K = -41° C

3) $P_1 = ?$ $\quad P_2 = 1.00$ atm

$V_1 = 322$ L $\quad V_2 = 197$ L

$T_1 = 37^\circ C + 273 = 310$ K $\quad T_2 = 0^\circ C + 273 = 273$ K

$P_1V_1/T_1 = P_2V_2/T_2$

$P_1 = P_2V_2/T_2 \times T_1/V_1$

$P_1 = 1.00$ atm x 197 ~~L~~ x 310 ~~K~~/(273 ~~K~~ x 322 ~~L~~) = 0.69 atm

4) $P_1 = 720$ mm $\quad P_2 = 360$ mm

$V_1 = 1.00$ L $\quad V_2 = 2.14$ L

$T_1 = 20.° C + 273 = 293$ K $\quad T_2 = ?$

$P_1V_1/T_1 = P_2V_2/T_2$

$T_2 = P_2V_2/P_1 \times T_1/V_1$

$T_2 = 360$ ~~mm~~ $\times 2.14$ ~~L~~ $\times 293$ K$/(720$ ~~mm~~ $\times 1.0$ ~~L~~$) =$ **313 K = 40.° C**

5) $P_1 = 756$ mm $\quad P_2 = ?$

$V_1 = 2.00$ L $\quad V_2 = 4.00$ L

$T_1 = 0.0° C + 273 = 273$ K $\quad T_2 = 137$ K

$P_1V_1/T_1 = P_2V_2/T_2$

$P_2 = P_1V_1/T_1 \times T_2/V_2$

$P_2 = 756$ mm $\times 2.00$ ~~L~~ $\times 137$ ~~K~~$/(273$ ~~K~~ $\times 4.00$ ~~L~~$) =$ **190. mm Hg**

6) $P_1 = 150$ atm $\quad P_2 = 755$ mm

$V_1 = 20.$ L $\quad V_2 = ?$

$T_1 = 30.° C + 273 = 303$ K $\quad T_2 = 22° C + 273 = 295$ K

$P_1V_1/T_1 = P_2V_2/T_2$

$V_2 = P_1V_1/T_1 \times T_2/P_2$

$P_2 = 150$ ~~atm~~ $\times 20.$ L $\times 295$ ~~K~~$/(303$ ~~K~~ $\times 755$ ~~mm~~ $\times 1$ ~~atm~~$/760$ ~~mm~~$) = 2940$ L

balloons = 1 balloon/5.0 ~~L~~ $\times 2940$ ~~L~~ $=$ **588 balloons**